3.2 Medical Requirements Overview

TABLE 3.2: MEDICAL REQUIREMENTS OVERVIEW

<table>
<tr><td>MRID# and Title:</td><td>MR043S Shuttle Air Quality Monitoring</td></tr>
<tr><td>Sponsor:</td><td>Medical Operations</td></tr>
<tr><td>IPT:</td><td>N/A</td></tr>
<tr><td>Category:</td><td>Medical Requirements (MR)</td></tr>
<tr><td>References:</td><td>JSC 13956 Medical Operations Requirements Document for Shuttle Missions
4.2.1 Air Quality Monitoring
4.2.1.1 Preflight
4.2.1.2 In-flight
4.2.1.3 Postflight</td></tr>
<tr><td>Purpose/Objectives:</td><td>• Preflight vehicle or module offgas testing assesses the current and the projected accumulation of volatile organic contaminants in all new Orbiters and any Orbiter or Spacehab that have undergone extensive refurbishment.
• To assess the prelaunch Orbiter air quality immediately prior to hatch closing.
• To assess the in-flight air quality by postflight analysis of archived samples.
• Provide real-time monitoring of specific combustion products following a fire or thermal degradation incident.</td></tr>
<tr><td>Measurement Parameters:</td><td>Identities of airborne volatile organic and selected inorganic compounds and their concentrations.</td></tr>
<tr><td>Deliverables:</td><td>• Preflight offgas report evaluating the projected accumulation of volatile organic compounds in all new Orbiters and any Orbiters or Spacehab that have undergone extensive refurbishment.
• Postflight report evaluating the air quality in the spacecraft based on preflight and in-flight sampling.</td></tr>
<tr><td>Flight Duration:</td><td>< 30 days</td></tr>
<tr><td>Number of Flights:</td><td>
<table>
<tr><td></td><td>Shuttle Air Quality Monitoring Hardware Overview</td></tr>
<tr><td>GSC</td><td>▪ Flown every Shuttle flight
▪ Sample taken once near end of mission
▪ Contingency GSC available</td></tr>
<tr><td>FMK</td><td>▪ Flown every Shuttle flight
▪ Sample taken once near end of mission
▪ Additional monitors available for contingency</td></tr>
<tr><td>CSA-CP</td><td>▪ Flown every Shuttle flight
▪ Activation/checkout near beginning of mission
▪ Available for contingency</td></tr>
</table>
</td></tr>
<tr><td>Number and Type of Crew Members Required:</td><td>One Shuttle crewmember will perform the in-flight monitoring and sample collection</td></tr>
<tr><td>Other Flight Characteristics:</td><td>N/A</td></tr>
</table>

3.3 Preflight Training

TABLE 3.3: PREFLIGHT TRAINING

<table>
<tr><td>Preflight Training Activity
Description:</td><td colspan="4">The Shuttle crew is trained in the collection of air samples using Grab Sample Containers (GSCs) during the Habitability Equipment Procedures briefing by the MOD (Mission Operations Directorate). GSC refresher training is also provided by MOD.

Crew training for the Compound Specific Analyzer-Combustion Products (CSA-CP) and Formaldehyde Monitor Kit (FMK) will be provided approximately 3-6 months before launch by Space Medicine Systems and Crew Training.</td></tr>
<tr><td rowspan="4">Schedule:</td><td colspan="2">Duration:</td><td>Schedule:</td><td>Flexibility:</td><td>Personnel Required:</td></tr>
<tr><td colspan="2">GSC procedures briefing 15 min</td><td>L-6 months</td><td>N/A</td><td>Crewmembers/MOD Trainers</td></tr>
<tr><td colspan="2">GSC refresher training 5 min</td><td>L-1 week</td><td>N/A</td><td>Crewmembers/MOD Trainers</td></tr>
<tr><td colspan="2">FMK, CSA-CP training 30 min</td><td>L- (3-6) months</td><td>N/A</td><td>Crewmembers/Trainers</td></tr>
<tr><td rowspan="2">Ground Support Requirements Hardware/Software</td><td colspan="3">Preflight Hardware:</td><td>Preflight Software:</td><td>Training Location:</td></tr>
<tr><td colspan="3">Grab Sample Containers (GSC)
Formaldehyde Monitoring Kit (FMK)
Compound Specific Analyzer-Combustion Products (CSA-CP)</td><td>N/A</td><td>U.S</td></tr>
<tr><td rowspan="4">Training Facilities</td><td>Minimum Room Dimensions:</td><td>Number of Electrical Outlets:</td><td>Temperature Requirements:</td><td colspan="2">Special Lighting:</td></tr>
<tr><td>8' x 10'</td><td>None</td><td>Ambient</td><td colspan="2">None</td></tr>
<tr><td>Hot or Cold Running Water:</td><td>Privacy Requirements:</td><td colspan="3">Other:</td></tr>
<tr><td>None</td><td>None</td><td colspan="3">Table & 4-6 chairs</td></tr>
<tr><td>Constraints/Special Requirements:</td><td colspan="5">None</td></tr>
<tr><td>Launch Delay Requirements:</td><td colspan="5">N/A</td></tr>
<tr><td>Notes:</td><td colspan="5">None</td></tr>
</table>

3.4 Preflight Activities

TABLE 3.4: PREFLIGHT ACTIVITIES

<table>
<tr><td>Preflight Activity
Description:</td><td colspan="4">Vehicle Offgas Testing: No crew time required
Prior to launch all new Orbiters and any Orbiter or Spacehab that have undergone extensive refurbishment shall undergo atmospheric offgas testing with periodic sampling using evacuated containers. Air samples from the Orbiter should be collected once the vehicle is as close as possible to flight configuration allowing a meaningful toxicological assessment. The ground-based sample frequency is determined by the JSC Toxicology Group.

Preflight sampling of the Orbiter for each mission: No crew time required
Immediately before hatch closure prior to launch, an evacuated canister is used to collect an air sample in the Orbiter. This sample is collected by Shuttle launch support personnel at KSC and returned within 72 hours to JSC Toxicology Laboratory for air quality analyses.</td></tr>
<tr><td rowspan="3">Schedule:</td><td>Duration:</td><td colspan="2">Schedule:</td><td>Personnel Required:</td></tr>
<tr><td>5 min/sample</td><td colspan="2">Offgas Testing: Sampling performed when Orbiter reaches predetermined level of configuration.</td><td>JSC Toxicology personnel in coordination with KSC</td></tr>
<tr><td>5 min/sample</td><td colspan="2">Preflight Sampling: Conducted immediately before hatch closure prior to launch.</td><td>KSC personnel collect the sample; analyses are performed by JSC Toxicology Laboratory</td></tr>
<tr><td rowspan="2">Ground Support Requirements Hardware/Software</td><td colspan="2">Preflight Hardware:</td><td>Preflight Software:</td><td>Test Location:</td></tr>
<tr><td colspan="2">Evacuated Containers</td><td>N/A</td><td>U.S.</td></tr>
<tr><td rowspan="4">Testing Facilities</td><td>Minimum Room Dimensions:</td><td>Number of Electrical Outlets:</td><td>Temperature Requirements:</td><td>Special Lighting:</td></tr>
<tr><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Hot or Cold Running Water:</td><td>Privacy Requirements:</td><td>Vibration/Acoustic Isolation:</td><td>Other:</td></tr>
<tr><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>Constraints/Special Requirements:</td><td colspan="4">None</td></tr>
<tr><td>Launch Delay Requirements:</td><td colspan="4">None</td></tr>
</table>

PREFLIGHT ACTIVITIES (CONT'D)

Notes:	The JSC Toxicology Laboratory is required to provide atmospheric offgas sample processing and analyses.
Data Delivery	**Data/Report to Designated Recipients (Nominal/Contingency):**
	The report from the vehicle offgas testing will be distributed to the Shuttle Program Office, Shuttle Commander, and Flight Surgeon within 1 month after the final sample is collected and will be available prior to launch. The Toxicology Laboratory will make available an air quality report based on preflight and in-flight sampling approximately 2-3 months following receipt of the postflight samples.

3.5 In-Flight Activities

TABLE 3.5.1a: IN-FLIGHT ACTIVITIES

<table>
<tr><td>In-Flight Activity Description:</td><td colspan="4">GSC Archival Sampling – A minimum of two Grab Sample Containers shall be manifested on each flight. One cabin air sample shall be taken near the end of the mission; the second GSC shall be available for contingency collection.</td></tr>
<tr><td rowspan="2">Schedule:</td><td>Activity:</td><td>Duration:</td><td>Schedule:</td><td>Personnel Required:</td></tr>
<tr><td>GSC Archival Sampling – includes unstow, deploy and stow</td><td>5 min/sample</td><td>Near end of mission (just prior to deorbit prep)</td><td>1 Operator</td></tr>
<tr><td>Procedures:</td><td colspan="4">Procedures are located in the Shuttle Orbit Ops book:
• Grab Sample Container Operations
A label on the GSC also lists the stepwise procedures for operation</td></tr>
<tr><td>Constraints / Special Requirements:</td><td colspan="4">• The container should be held away from the body during sample collection.
• Additional GSC sample will be collected in response to air quality issues in a contingency situation.
• Date, time, and location of sampling will be recorded.</td></tr>
<tr><td>Photo / TV Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Cold Stowage Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Mission Extension Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Landing Wave-Off Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Data Delivery</td><td colspan="4">Data/Report to Designated Recipients (Nominal/Contingency):</td></tr>
<tr><td></td><td colspan="4">Following each mission the JSC Toxicology Group shall make available a report approximately 2-3 months following receipt of the postflight sample that assesses the air quality during the mission according to the methods in JSC 20584 (Spacecraft Maximum Allowable Concentrations for Air-Borne Contaminants) and ISO 9000 work instructions. This report will be distributed to the Shuttle Program Office, Shuttle Commander, Flight Surgeon, and others as required.</td></tr>
</table>

TABLE 3.5.1b (In-flight Activities cont'd.)

<table>
<tr><td>In-Flight Activity Description:

Schedule:</td><td colspan="4">FMK Sampling – Formaldehyde monitors are deployed in duplicate (pairs), side-by-side at designated sampling locations for 24-48 hours (unattended). One sampling session will occur near end of mission; additional FMKs are available for off-nominal sampling, as needed.</td></tr>
<tr><td></td><td>Activity:</td><td>Duration:</td><td>Schedule:</td><td>Personnel Required:</td></tr>
<tr><td></td><td>FMK Sampling – includes unstow, deploy, retrieval, and stow</td><td>10 min/sample

24-48 hours unattended sampling</td><td>One 24-48 hour sampling period near the end of the mission</td><td>1 Operator</td></tr>
<tr><td>Procedures:</td><td colspan="4">To be located in the Shuttle Orbit Ops Book</td></tr>
<tr><td>Constraints / Special Requirements:</td><td colspan="4">▪ Date, time, and location of sampling are recorded on each monitor
▪ Sampling period is 24-48 hours unattended
▪ Sampling location should not be near air supply fans or in a stagnant air location
▪ Monitors must be deployed in duplicate (pairs), side-by-side
▪ Formaldehyde monitors may be used to collect air samples in the event of a contingency</td></tr>
<tr><td>Photo / TV Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Cold Stowage Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Mission Extension Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Notes:</td><td colspan="4">Additional formaldehyde monitors are included in the Kit for contingency use.
Toxicology laboratory provides the timeline flight planners & Flight Activities Office the predetermined sample locations for FMK. These locations are documented in the procedures located in the Shuttle Orbit Ops book.</td></tr>
<tr><td>Data Delivery</td><td colspan="4">Data/Report to Designated Recipients (Nominal/Contingency):</td></tr>
<tr><td></td><td colspan="4">Following each mission the JSC Toxicology Group shall make available a report approximately 2-3 months following receipt of the postflight sample that assesses the air quality during the mission according to the methods in JSC 20584 and ISO 9000 work instructions. This report will be distributed to the Shuttle Program Office, Shuttle Commander, Flight Surgeon, and others as required.</td></tr>
</table>

TABLE 3.5.1c (In-flight Activities cont'd.)

<table>
<tr><td>In-Flight Activity Description:</td><td colspan="4">CSA-CP sampling provides real-time monitoring for potential combustion products in a contingency situation. Presently, the current crew will activate, deploy, and zero-calibrate the CSA-CP near the beginning of the mission, and stow the CSA-CP near end of the mission. This is a temporary requirement and is expected to be deleted following the certification of a new battery pack for the CSA-CP. The CSA-CP will continue to be available for contingency combustion incidents.</td></tr>
<tr><td>Schedule:</td><td>Activity:</td><td>Duration:</td><td>Schedule:</td><td>Personnel Required:</td></tr>
<tr><td></td><td>CSA-CP Activation/Checkout – includes unstow, deploy, zero-calibrate</td><td>15 min. for activation/checkout, deploy, zero-calibrate</td><td>Near beginning of mission,</td><td>1 Operator</td></tr>
<tr><td></td><td>CSA-CP Stow</td><td>5 min. for Stow</td><td>Near end of mission</td><td>1 Operator</td></tr>
<tr><td></td><td>CSA-CP Contingency</td><td>As needed</td><td>As needed</td><td>1 Operator</td></tr>
<tr><td>Procedures:</td><td colspan="4">Procedures are located in the Shuttle Orbit Ops book:
• Compound Specific Analyzer-Combustion Products</td></tr>
<tr><td>Constraints / Special Requirements:</td><td colspan="4">None</td></tr>
<tr><td>Photo / TV Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Cold Stowage Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Mission Extension Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Landing Wave-Off Requirements:</td><td colspan="4">N/A</td></tr>
<tr><td>Data Delivery</td><td colspan="4">Data/Report to Designated Recipients (Nominal/Contingency):</td></tr>
<tr><td></td><td colspan="4">A final report assessing any data collected by the CSA-CP will be provided to the Shuttle Program Office, Shuttle Commander, Flight Surgeon, and others as required, no later than 1 month after receipt of the data</td></tr>
</table>

3.5 In-Flight Activities (cont.)

TABLE 3.5.2: IN-FLIGHT HARDWARE

Hardware/Software Name	P/N	Orbiter Location	Vehicle (Up/Dn)	Category	Late Access / Early Destow/ Early Return	Docked Ops	Weights (kg)	Volume (cm^3)	Dimensions LxWxH (cm)	Power (watts)	Resupply	Download / Downlink
Grab Sample Container (GSC)	SDD46108778-XXX	Middeck	Shuttle	GFE	LA= N/A ED=R+3 hrs ER=R+24-48hrs	N/A	0.50	2041	18.8 x 8.9 x 12.2	N/A	N/A	N/A
Formaldehyde Monitoring Kit (FMK)	SDD46108168-XXX	Middeck	Shuttle	GFE	LA= N/A ED=R+48 hrs ER=R+1 wk	N/A	0.10	792	22 x 3 x 12	N/A	N/A	N/A
Compound Specific Analyzer-Combustion Products (CSA-CP)	SED46116968-XXX	Middeck	Shuttle	GFE	LA= L-3 wks ED= R+48 hrs ER= R+1 wk **See Note 1 below**	N/A	1.8	3740	30.5 x 10.2 x 12.1	Battery	N/A	N/A

Note 1: If the CSA-CP is operated during a contingency event, then an early destow of R+3 hours and early return of R+24 hours is required.

3.6 Postflight Activities

TABLE 3.6: POSTFLIGHT ACTIVITIES

Postflight Activity Description:	See Table 3.5.2 In-flight Hardware, Early Destow			
Schedule:	**Duration:**	**Schedule:**	**Flexibility:**	**Personnel Required:**
	N/A	N/A	N/A	N/A
Ground Support Requirements Hardware/Software	**Postflight Hardware:**	**Postflight Software:**	**Test Location:**	
	N/A	N/A	N/A	
Testing Facilities	**Minimum Room Dimensions:**	**Number of Electrical Outlets:**	**Temperature Requirements:**	**Special Lighting:**
	N/A	N/A	N/A	N/A
	Hot or Cold Running Water:	**Privacy Requirements:**	**Vibration/Acoustic Isolation:**	**Other:**
	N/A	N/A	N/A	N/A
Constraints/Special Requirements:	N/A			
Early Destow / Early Return:	The air quality monitoring and sampling hardware have early destow/early return schedules. See Table 3.5.2 for specific requirements. Stowage and transportation temperatures should not exceed 110ºF.			
Notes:	N/A			
Data Delivery	**Data/Report to Designated Recipients (Nominal/Contingency):**			
	The Toxicology Laboratory will make available an air quality report based on preflight and in-flight sampling approximately 2-3 months following receipt of the postflight samples. This report will be distributed to the Shuttle Program Office, Shuttle Commander, Flight Surgeon, and others as required. At the crew surgeon's request a "quick look" preliminary report will be provided within a few weeks of landing.			

3.7 Summary Schedule

TABLE 3.7: SUMMARY SCHEDULE

ACTIVITY	DURATION	SCHEDULE	PERSONNEL REQUIRED	CONSTRAINTS
Preflight Training				
Habitability Equipment Procedures Briefing for GSC operation	15 min	L-6 months	Crewmembers/MOD Trainers	None
Refresher Training for GSC operation	5 min	L-1 week	Crewmembers/MOD Trainers	None
FMK, and CSA-CP training	30 minutes	L- (3-6) months	Crewmembers/Trainers	None
Preflight Activity				
Vehicle Offgas Testing: Atmospheric sampling of vehicle or module – No crew time required	5 min/sample	Sampling done when vehicle reaches predetermined level of configuration.	JSC Toxicology Personnel in coordination with KSC	None
Preflight Sampling: Orbiter air sampling – No crew time required	5 min/sample	Sampling conducted immediately prior to hatch closure before launch.	KSC personnel conduct sampling; JSC Toxicology performs analyses.	None
In-Flight				
Grab Sample Container (GSC) Archival Sampling – includes unstow, deploy, stow	5 min/sample	Near end of mission or in contingency	1 Operator	-The container should be held away from the body during sample collection -Date, time, location will be recorded -GSC deployment may occur in response to air quality issues or when requested by Flight Surgeon

Table 3.7 Summary Schedule (continued)

ACTIVITY	DURATION	SCHEDULE	PERSONNEL REQUIRED	CONSTRAINTS
Formaldehyde Monitoring Sampling (FMK)	10 min/sampling	One sampling session near end of mission	1 Operator	-Date, time, and location of sampling are recorded on each monitor. -Sampling period is 24-48 hrs unattended. -Sampling location should not be near air supply fans or in area with poor air flow. -Formaldehyde monitors may be used to collect air samples in the event of a contingency. -Monitors must be deployed in duplicate (pairs), side-by-side.
Compound Specific Analyzer-Combustion Products (CSA-CP) Activation & Checkout	15 min. for activation/checkout, deploy, zero-calibrate	Near beginning of mission	1 Operator	The current crew procedure to activate and deploy the CSA-CP is a temporary requirement. This requirement is expected to be deleted following the certification of a new battery pack for the CSA-CP.
CSA-CP Stow	5 min. for stow	Near end of mission		
CSA-CP Contingency combustion incidents	As needed	As needed	1 Operator	Deployed in response to air quality issues or when requested by Flight Surgeon.
Wheels-Stop: N/A				
Postflight: N/A				
Postflight Debrief: N/A				